



State of Montana

Department of Transportation

Rail, Transit and Planning Division / Multimodal Planning

Highway Economic Evaluation Tool, version 2

Requirements Document

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Glossary of Terms:

- HEAT** Highway Economic Analysis Tool - this refers to the original HEAT application.
- HEAT2** Highway Economic Analysis Tool, version 2 - this refers to the new HEAT application.
- HPMS** Highway Performance Monitoring System - A major purpose of the HPMS is to provide data that reflects the extent, condition, performance, use and operating characteristics of the Nation's highways. These data are also used for assessing highway system performance under FHWA's strategic planning process and for apportioning Federal-aid funds.
- P3** The Department of Transportation's Performance Programming Process (P3) ensures that the best system wide investment decisions are made, given: Overall direction from our customers; available resources; and system performance monitored over time. MDT defines P3 as: "A method to develop an optimal investment plan and measure progress in moving toward strategic transportation system goals" One of the main components of P3 is asset management. Asset management is a process to strategically manage the transportation system in a cost-effective, safe, efficient, and environmentally sensitive manner.
- PET** Preliminary Estimating Tool– is a parametric cost estimating tool that uses average bid prices for selected roadway items and adjustment formulas based on project type related assumptions.
- STIP** Statewide Transportation Improvement Program The STIP is a Federally required publication that shows funding obligations over a three-year period. This program identifies highway, rail, aeronautic, and transit improvements to preserve and improve Montana's transportation system. Although the projects and dates in the STIP are MDT objectives, the execution of this program is contingent on a number of factors, including federal and state funding availability, right-of-way acquisition, utility relocations, environmental review, surveying, and design. Complications with one or more of these factors may delay a project.
- TCP** Tentative Construction Plan/Program This is used to determine tentative funding availability and the optimum future federal-aid project/program funding mix. Coordinates communication between Department personnel within the Administration, Engineering, Motor Carrier Services, and Rail, Transit and Planning Divisions to ensure compliance operating procedures related to Federal Funding Legislation.
- TIS** Transportation Information System TIS is several things. First, it is the migration from the old mainframe-based Highway Information System (HIS) to Oracle and the windows environment. Second, it is a set of interrelated automated systems such as the Road Log, Traffic, Accidents, Congestion, Pavement, etc., which support operational and management decision processes. Third, it is a system which provides "anchoring mechanisms" such as uniform project numbering, base routes, nodes, links, points, segments, and corridors, and "common services" such as GIS (Geographic Information System) utilization, roadway imaging access, dynamic segmentation, and navigation which enable us to share and correlate information dynamically between automated systems.



Contents

1.0	Introduction	1
1.1	Background.....	1
1.2	Project Goals.....	2
1.3	Project Objectives	2
2.0	Scope	4
3.0	HEAT Background.....	5
3.1	Current Business Functions	5
3.2	Current Deficiencies	7
4.0	Requirements	9
4.1	General Requirements	10
4.2	Input & Output Requirements	11
4.3	Data Requirements	13
4.4	Functional Requirements.....	16
4.5	Performance and Quality Requirements	19
4.6	Security and Access Requirements.....	19
4.7	Communication Requirements	20
4.8	Backup, Restore and Recovery Requirements.....	20
4.9	Training Requirements	20
4.10	Ongoing Maintenance and Support Requirements	21
	Appendix A - Business Data Model.....	22
A 1.0	Data Models	22
A 1.1	Allocation of Direct Benefits to Industries	22
A 1.2	Business Attraction Model Steps:.....	23
A 1.3	Benefit/Cost Analysis:.....	24
A 1.4	Performance Programing Process (P3) Process:	25
A 1.5	Cost estimation/PET:	26
A 2.0	Data Entity Descriptions.....	27
A 3.0	Data Entity Relationships	27
A 4.0	Data Element Descriptions	27
A 5.0	Example Reports	28
	.....	7
	.....	7
	.....	8
	.....	8
	.....	9



Stakeholder’s Acceptance/Approval 9

Draft



Requirements Document (CEP FINAL DRAFT)

1.0 Introduction

1.1 Background

During the early 2000's the MDT conducted multiple studies on the economic effects of highway improvement scenarios. The main objective was to develop a sophisticated methodology to compare and analyze the relative economic benefits of transportation investments. Cambridge Systematics developed a Geographic Information Systems (GIS) based system that automated the process of economic analysis utilizing Esri's ArcGIS Desktop Software version 9, with interfaces to ArcView version 3.3, as well as the Regional Economic Models Inc. (REMI PI) Software. The original HEAT was designed to enable quick and consistent economic impact analysis of transportation projects. It provides a graphical user interface (GUI) and a series of functions and tools focused at guiding the user through typical and repeatable steps to analyze and model the economic impact of highway improvement scenarios. This allows the user to quantify the costs and benefits associated with potential improvements, whether project-by-project or in groups.

The original HEAT was written in Avenue for Esri's ArcView 3.x and partially updated to Microsoft Visual Basic for Applications (VBA) as macro to the ArcGIS Desktop environment. Avenue has long been deprecated and recently VBA has been deprecated by Microsoft. With the release of ArcGIS version 10 in 2010, Esri officially deprecated VBA and macros are no longer available in the product without additional configuration. Esri's ArcGIS Desktop has moved to the Add-in model similar to other Windows based products such as Microsoft Office or Mozilla Firefox. Add-ins cannot be coded within the desktop software itself, instead requiring the use of an Integrated Development Environment (IDE) where the modules are coded, built and then deployed to the software. ArcGIS Server now shows the potential to complete all processing, allowing users to interact with the program through a web interface and significantly reduce software dependencies.

The broad goals of HEAT2 (Highway Economic Analysis Tools, version 2) can be summed up in the following points:

- Identify net costs and benefits of specific transportation investments for Montana's districts and industries.
- Provide MDT with an analytical toolbox to evaluate economic development impacts of transportation improvements. For instance, HEAT2 should enable analysis of selected projects in the State Transportation Improvement Plan.
- Apply the analytical toolbox to quantify the impacts of transportation improvement scenarios as part of MDT's planning process.
- Provide an extensible system design so that HEAT2 can be modified by changing or adding features to meet future highway program requirements. Data should be modular and easy to update.

The applications of HEAT2 are multiple:

- Long-Range Policy Plan Updates



- Corridor-level analysis
- Investment Analysis
- Investment strategy
- Community or industrial development analysis
- Packages of reconstruction work that add capacity
- District Nomination Process
- Screen and rank projects
- Five-Year Tentative Construction Program (TCP) development
- Project implementation for EIS (Environmental Impact Statement) evaluation

1.2 Project Goals

The goal of this project is to deploy a new version of the Highway Economic Analysis Tool (HEAT). This new version, named HEAT2 will include an update of the design and programming of the original tool while maintaining the original functionality. HEAT2 will be compatible with current versions of software noted below. The HEAT2 design will be extensible and sufficiently flexible to meet changing Federal, State and Agency requirements.

1.3 Project Objectives

Deploy a working version of HEAT2 compatible with the current version ArcGIS Software and outputs to be compatible with the current version ArcGIS for Desktop. Geoprocessing and ArcObjects functionality will be performed with current version of ArcGIS for Server, or alternatively Desktop. Numeric outputs from HEAT2 will be provided in formats usable in current version of Microsoft Excel. The interfaces to the REMI program will be capable of executing with the current version. The application will be flexible to updates in ArcGIS, Microsoft Office, and REMI software

- Maintain the current modeling capabilities of the original HEAT without significantly altering the algorithms that process the data. Make that processing happen in the current software versions and with dynamic data sources from internal MDT systems.
- Provide the functionality for the end user to reconstruct the roadway network based upon the dynamic data sources. Provide the user with a configuration that allows them to alter where maintained data sources reside, such as in an ArcSDE database.
- Utilize the PET (Preliminary Estimating Tool) spreadsheet in the model processing; provide a façade wrapper or similar solution to provide a service for cost estimation to be consumed by the HEAT2 program. The purpose of the service to allow changes to happen to PET and allow another estimation tool to be connected to HEAT2 when the PET reaches end-of-life and is replaced.
- Allow users to easily create and attribute new roadways for improvement scenarios such as realignments, also allow user to attribute improvement scenarios on existing roadways. This can be achieved either in the ArcGIS for Desktop program or through a web browser, preferably a standard web browser, such as IE 8+.
- Preserve completed HEAT2 improvement scenarios, their parameters, inputs and output indefinitely. Allow the end user to select from previously created scenario and use that as the basis for a new HEAT2 scenario.



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2.0 Scope

HEAT is a program that aids in economic evaluation of highway improvement scenarios. It provides a graphical user interface (GUI) and a series of functions and tools focused at guiding the user through typical and repeatable steps to analyze and model the economic impact of highway improvement scenarios. This allows the user to quantify the costs and benefits associated with potential improvements.

There are several primary analysis modules within HEAT that are linked in order to provide the cost-benefit analysis.

Throughout, the main parameters should be easy to access and update so the model can be kept in accord with changing conditions and software:

Travel Network Model – Highway improvement scenarios are analyzed against a travel network model which models driving conditions for both commodity-based and non-freight trucks as well as auto traffic.

User Benefits - Using the results of the travel network model, user benefits of highway improvements are quantified comparing them to no build scenarios. User benefits include travel time savings, operation costs, and safety

Value of Time – The value of time is variable depending on the type of trip and/or the commodity being shipped. The value of auto trips can be quantified by a standard number per hour, the time value or truck trips vary depending on the type of commodity being shipped.

Business Attraction – Upgraded transportation infrastructure has the potential to lead to business attraction. Faster travel times can lead to increased market availability.

Tourism – Improved infrastructure also generates additional tourism.

Economic Impacts – Direct economic impacts such as user benefits, business attraction, and tourism can be input into the economic stimulation model and helps estimate the impacts of a given highway improvement scenario.

Cost Estimation – Based on the project scenario factors such as miles and upgrade specifications (bridge cost, pavement, etc), HEAT factors in the price estimations from both the initial project costs and ongoing maintenance. MDT's [Preliminary Estimation Tool](#) (PET) has cost estimation that should be incorporated into HEAT2.

Benefit/Cost Analysis – The final module performs the benefit/cost analysis given all of the linked analysis above. Benefits include such measures as gross state product (GSP) for Montana businesses, in addition personal auto user benefits are also included that are not part of the economic impact analysis.

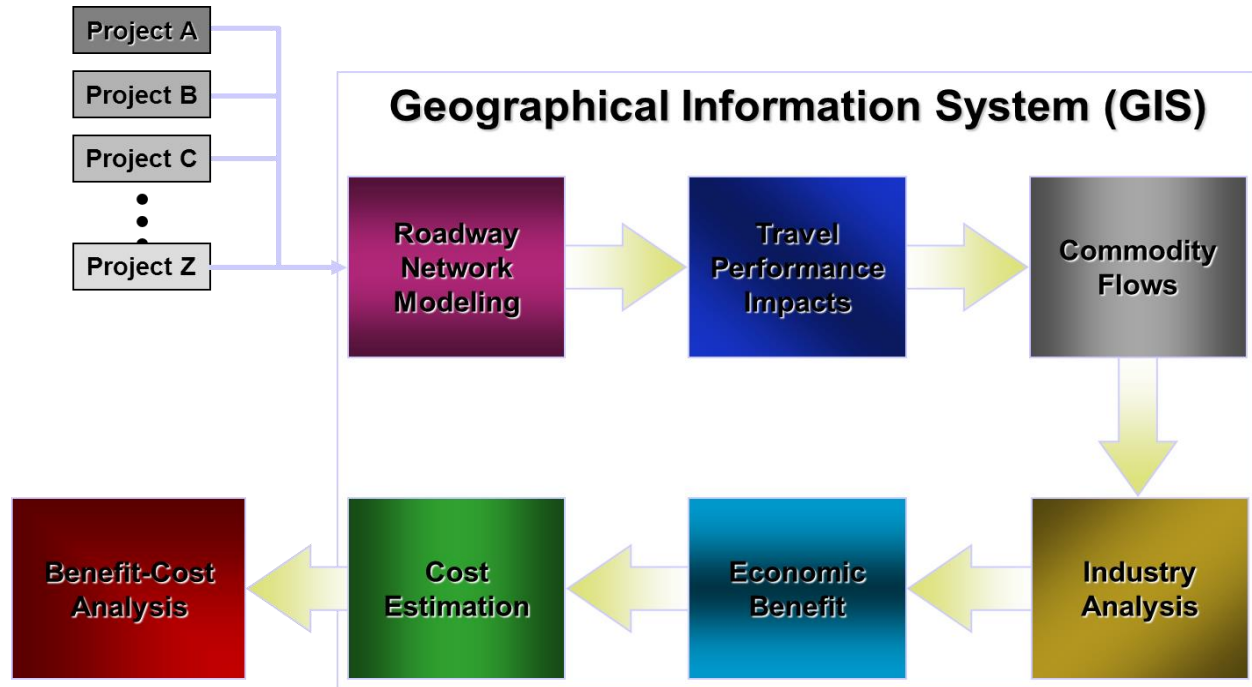


Figure 1: The HEAT Analysis, dependent and linked to perform the final Benefit-Cost Analysis.

3.0 HEAT Background

HEAT was originally written Avenue for Esri's ArcView 3.x and partially updated to Microsoft Visual Basic for Applications (VBA) as macro to the ArcGIS Desktop environment. Avenue has long been deprecated and recently VBA has been deprecated by Microsoft. With the release of ArcGIS version 10 in 2010, Esri has officially deprecated VBA and macros are no longer available in the product without additional configuration. Esri's ArcGIS Desktop has moved to the Add-in model similar to other Windows based products such as Microsoft Office or Mozilla Firefox. Add-ins cannot be coded within the desktop software itself, instead requiring the use of an Integrated Development Environment (IDE) where the modules are coded, built and then deployed to the software. ArcGIS Server now shows the potential to complete all processing, allowing users to interact with the program through a web interface and significantly reduce software dependencies.

3.1 Current Business Functions

The current HEAT module is not fully functional, many fixes were employed during the summer of 2011 which allowed HEAT to run, but the static data source were outdated and the REMI models used older versions. The program remained cumbersome.



HEAT is used to perform cost-benefit analysis of a given highway improvement scenario, it is envisioned to be integrated in the Performance Programming Process, and used for all STIP process and run all TCP projects.

Each step within HEAT is somewhat dependent upon the next; the following diagram depicts the process:

Montana HEAT Model

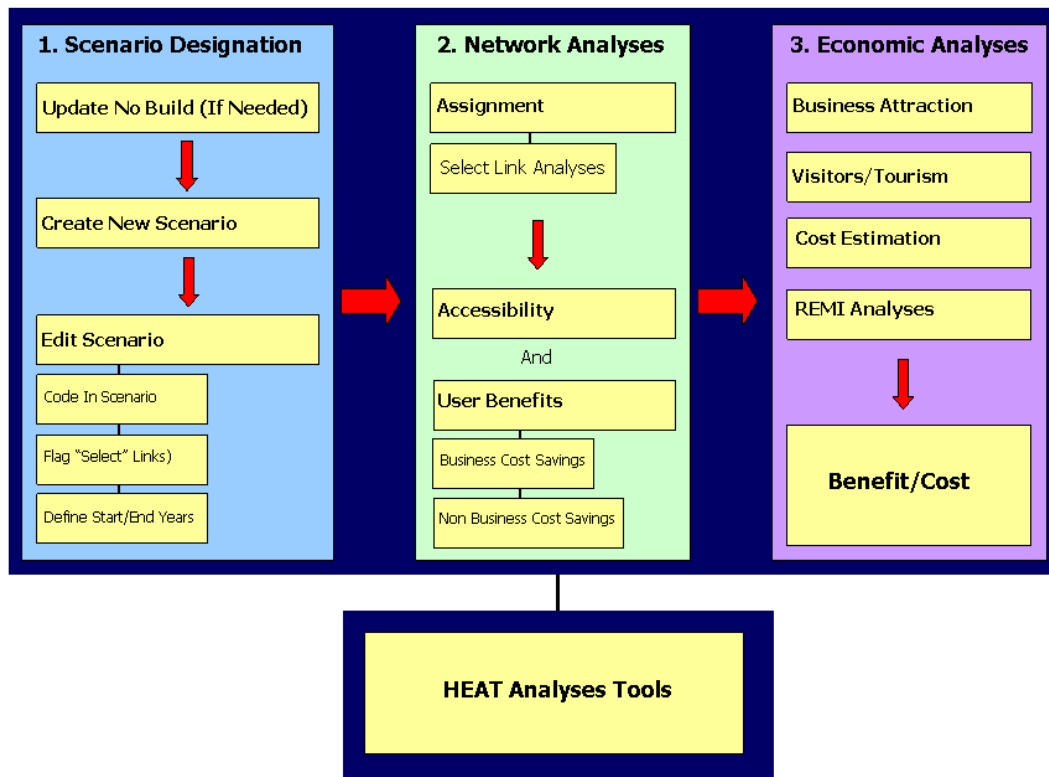


Figure 2: HEAT Modules and flow diagram.

Here is a list of the major modules and key processes of the current version:

- Scenario Designation
 - Establish scenario
 - Code project and attributes of projects
- Network Analysis Tools
 - Assignment routine
 - Accessibility analysis
 - User benefit Analysis
- Economic Analysis
 - Tourist spending effects



- Business attraction
 - Cost estimation
 - Economic growth by industry
 - Interface to REMI model
 - Cost-Benefit analysis
- User Exploration Tools
 - Map data
 - Desire lines
 - Document exploration

3.2 Current Deficiencies

The following deficiencies were identified by the Planning team as part of the summer of 2011 effort to use HEAT.

- Current version of software.

HEAT is an integrated program that runs off of ArcGIS, ArcView, REMI, and Microsoft Excel, but today only runs on outdated versions of these programs. HEAT is also programmed using VBA & Avenue, which ArcGIS has migrated away from. Due to these software evolutions, a legacy computer is now the only way to run HEAT. The program is prone to difficulties. The task is to update HEAT to current software standards for ArcGIS suite and the other integrated programs especially REMI and Excel, and to make it more robust in anticipation of inevitable changes in software. Key parameters should be easy to locate and update, such as the speed and reliability of a road, the cost of a project, or the value of inputs such as travel time and fuel cost.
- Preliminary Estimation Tool (PET).

HEAT's module for estimating costs has been extracted by MDT and enhanced. MDT has taken this component and integrated it into engineering cost estimation work. The PET has updated prices and added planning-level estimations costs of bridges. The problem is that HEAT2 must re-establish a link to this function – a source external to the HEAT software, but internal to MDT. The task is to work with MDT owners of the PET and create a link to this external source, integrating it into HEAT2.
- No-build Scenario.

When HEAT calculates the changes that occur when a roadway is modified it compares them to the No-Build Scenario. This base network model reflects current conditions of all highways in the state, but it has not been thoroughly updated since 2006. All projects completed by MDT since then must be updated. This can be done by using the "Edit No-Build Network" command in the HEAT editor and changing each individual road segment, however a programmatic approach and link to the MDT TIS road log (Oracle database) may be more practical. The task is to update the No-build scenario.
- Link HEAT2 to GIS and other data sources.



Similar to the PET and No-build updates, there are various needs for linking HEAT2 to actively managed internal processes and databases. Updated roadway attribution is available in the TIS road log, HPMS database and TCP GIS database but HEAT is not linked to those sources. Simply establishing the basic starting point for a HEAT analysis requires substantial effort that duplicates other routine work of the department and is prone to error. HEAT currently requires an annual process of doing and undoing the base case scenario as some projects are completed, some delayed or hastened, and some new ones added. For instance, the five year TCP may be hand-built into HEAT, but only one (of five) years' worth of projects is completed in the analysis. The vision is that HEAT2 would be updated to facilitate updates to the no-build scenario using GIS or other data available within MDT from the HPMS, TCP, and/or road log. How to accomplish this is open for discussion.



- Integrate departmental inflation estimates into HEAT/PET.
Since development of HEAT, MDT has institutionalized an inflation forecasting process. Inflation estimations have been embedded into tools routinely used in project cost estimation. The task here would be to reference departmental inflation parameters and integrate them into the HEAT2 program.
- Fix Permission Issues.
HEAT is designed to write to local drives in a way that is restricted by the state for security purposes, and this has always been a problem. It has necessitated a number of work-arounds that are hard to negotiate and have never operated smoothly. (Currently, in order for REMI to run with HEAT the program must be run as an administrator, and the state disallows this practice.) Additionally, in order for the Excel spreadsheets to interface correctly macros must be enabled by default. This is another security issue for our MDT Information Services Division and State Department of Administration. The task is to program HEAT2 so that it and its component elements accord with MDT Information Services Division and Department of Administration standards.

After HEAT's initial development, other states looked into the benefits of assessing and quantifying the economic development impacts using HEAT. Horowitz et al. (2007) analyzed the business attraction module, and much of the study focused on this innovation, but also identified some general deficiencies:

- HEAT is calibrated specifically for Montana.
- Data requirements for HEAT may be unwieldy.
- HEAT requires a seamless execution of several software packages which all require their own special expertise.

This project is specifically for Montana, but the Data and Software requirements are a key deficiency for the current program. The integration of multiple software packages has proven to be an ongoing maintenance headache. Moving to a Service Oriented Architecture could alleviate some of these deficiencies by not injecting dependencies from one software module to the next.

4.0 Requirements

This section states the functions required of the software in quantitative and qualitative terms, and what the system must do to completely fulfill expectations.

Each paragraph contains a reference identifying the source of the requirement. Each requirement is numbered, e.g., G-01, or F-01.1, etc. Only one requirement is defined per numbered item.

Each requirement should be classified as one of the following:

1. **Mandatory** - Absolutely essential feature; project will be canceled if not included
2. **Required** - Individual features are not essential, but together they affect the viability of the project.



3. **Desired** - Nice-to-have feature; one or more of these features could be omitted without affecting the project viability.

4.1 General Requirements

The project goals provide a clear list of the expectations of a new system, both in terms of what must be improved and what must be retained from the current processes. All other detailed requirements address one or more of these goals.

#	Priority	Requirement Description
G-01	R	New functionality must utilize dynamic MDT data sources.
G-02	M	Economic modeling capability maintained from current version.
G-03	R	New functionality utilizes current software versions (REMI, ArcGIS, Excel or similar).
G-04	R	Cost estimation module must utilize MDT's Project Estimation Tool (PET). http://mdtinfo.mdt.mt.gov/highways/cost.shtml
G-05	R	Program allows user to easily create and attribute <i>new</i> scenarios on a map through standard ArcGIS editing tools or web-based editing tools.
G-06	M	Program allows user to easily attribute scenarios on a map through standard ArcGIS editing tools or web-based editing tools on <i>existing</i> roadways.
G-07	D	Reports, graphs and charts of outputs maintained from current version.
G-08	R	Provide the output in an easy to use format (Excel and GIS) and in a standard, accessible folder structure or easily retrieved from system.
G-09	R	Final benefit-cost numbers are needed on the following levels: <ul style="list-style-type: none">• District• State
G-10	R	Provide a model parameter page in a similar fashion to the current cost estimation page. Allows user to input parameters such as the price of gasoline, value of life, oil price index, and value of time, inflation estimates, and others.
G-11	R	Provide functionality for the user to select which modules to run for the scenario.



G-12	R	Save the processed scenarios indefinitely, in a way that is easily queried and results are accessible.
G-13	R	Once the parameters and modules are specified by the user, the model runs through completion without any further user interaction.
G-14	D	Provide notification to the user when the model has completed.
G-15	D	From the initiation of a scenario, the processing time should be less than one hour.
G-16	D	Source code to be open.

4.2 Input & Output Requirements

The inputs and outputs requirements provide a description of all manual and automated input requirements for the software product such as data entry from source documents and data extracts from other applications, as well as all output requirements for the software product such as printed forms, reports, display screens, files and other deliverables the system will process and produce.

#	Priority	Requirement Description
G-01: New functionality must utilize dynamic MDT data sources.		
IO-01.1	R	HEAT2's network will be stored in the enterprise geodatabase and updated dynamically from TIS and other internal sources where necessary.
IO-01.2	R	HEAT2 will allow a user to select a project or projects from the TCP and it will be processed as a HEAT scenario with little or no modification to the TCP
G-02: Economic Modeling capability maintained from current version.		
IO-02.1	M	HEAT2 must format the inputs to the REMI model.
IO-02.2	M	HEAT2 will return the results for REMI in user accessible formats.
G-03: New Functionality utilizes current software versions.		
IO-03.1	R	HEAT2 will format the input to the REMI model meeting the specification of the latest REMI version: Pi++ v 1.3.5.



HEAT2 – Requirements Document

IO-03.2	R	HEAT2 will utilize data stored in database format compatible with ArcGIS software version 10.1.
IO-03.3	R	HEAT2 will output data into GIS formats compatible with ArcGIS 10.1 and tabular data that can be consumed in Microsoft Excel 2010.
G-04: Cost estimation module must utilize the standard inflation estimate form MDT's Project Estimation Tool (PET).		
IO-04.1	R	The user will complete the PET spreadsheet will be used as an input to HEAT2. Within the program, similar projects will be agglomerated for purposes of PET cost estimation.
IO-04.2	R	HEAT2 will utilize the updated PET spreadsheet/s to process the cost estimation module.
G-05: Program allows user to easily create and attribute <i>new</i> scenarios on a map through standard ArcGIS editing tools or web-based editing tools.		
IO-05.1	R	HEAT2 will copy a scenario network from the no build network and the user will edit the attributes and geometry. HEAT will incorporate the new geometry into the network before it is used as the model's input.
IO-05.2	D	The scenario network will be made available to the user after the model is completed.
G-06: Program allows user to easily attribute scenarios on a map through standard ArcGIS editing tools or web-based editing tools on <i>existing</i> roadways.		
IO-06.1	M	HEAT2 will copy a scenario network from the no build network; the user will edit the attributes, before it is used as the model's input.
G-07: Reports, graphs and charts of outputs maintained from current version.		
IO-07.1	D	The output charts, graphs, and GIS files will be similar to the current version and available to the user in formats compatible to current MDT standard software (Excel, ArcGIS).
G-08: Provide the output in an easy to use format (Excel and GIS) and in a standard, accessible folder structure or easily retrieved from system.		
IO-08.1	R	Outputs from HEAT2 will be accessible to the user and compatible with current version of ArcGIS and Excel.



IO-08.2	R	Outputs will either be stored in an accessible folder structure or be retrievable indefinitely.
G-09: Benefit-cost numbers are needed on the following levels: County, District, and State.		
IO-09.1	R	The output of the cost benefit will be quantified in terms of County (if possible), District and State.
IO-09.2	R	GIS outputs will be linked to their appropriate levels: County, District, and State.
G-10: Provide a model parameter page in a similar fashion to the current cost estimation page. Allows user to input parameters such as the price of gasoline, value of life, oil price index and others.		
IO-10.1	R	Provide an input parameter page to the user, allowing them to adjust key parameters.
G-11: Provide a function for the user to select which modules to run for the scenario.		
IO-11.1	R	Allow the user to select which optional modules to process before the model initiates.
G-12: Save the processed scenarios indefinitely, in a way that is easily queried and results are accessible.		
IO-12.1	R	Save the scenario's input parameters, modules, cost estimation, and scenario indefinitely
IO-12.2	R	Save the scenario's output indefinitely.
G-14: Provide notification to the user when the model has completed.		
IO-14.1	D	Once the model has finished processing, provide the user with an email notification of completion, including links to the outputs.

4.3 Data Requirements

Data requirements identify the data elements and logical data groupings that will be stored and processed by the software product, H2. This includes the archiving of data and sensitivity of data.



#	Priority	Requirement Description
G-01: New functionality must utilize dynamic MDT data sources.		
D-01.1	M	HEAT2 must utilize data from production MDT database (Oracle Spatial and ArcSDE-Oracle).
D-01.2	D	GIS data essential to modeling and mapping will be stored in the enterprise geodatabase (ArcSDE-Oracle).
D-01.3	R	Provide data configuration, accessible and editable to the users.
D-01.4	R	The HEAT2 no-build network will link to dynamic data sources including TIS (Oracle). Provide a repeatable method to update the HEAT2 Network from the dynamic sources.
D-01.5	R	HEAT2 will allow a user to select from the TCP and process as a scenario. Provide a configuration entry for the location of the TCP projects, a way to select the project and process as scenario.
D-01.6	D	Non-spatial data elements for HEAT2 will be stored in a database.
G-02: Economic modeling capability maintained from current version.		
D-02.1	M	Provide a HEAT2 network containing linkage to dynamic MDT data sources.
D-02.2	D	Provide the user with the functionality to update the HEAT2 network based on the dynamic data sources.
D-02.3	D	Once the network has been updated, run the analyses common to all scenarios and save that data to be retrieved during scenario processing.
D-02.4	R	Maintain GIS Data sources essential to economic modeling in the enterprise geodatabase.
G-03: New functionality utilizes current software versions (REMI, ArcGIS, Excel or similar).		
D-03.1	R	Maintain data sources, inputs & outputs in compatible formats to the three major software components: ArcGIS, Excel, and REMI.
G-04: Cost estimation module must utilize MDT's Project Estimation Tool (PET).		



D-04.1	R	Utilize the current PET spreadsheet for the cost estimation module.
D-04.2	D	Use of PET should be developed in a way that a new tool could be plugged into the module. Provide the users a configuration method for the cost estimation module.
G-05: Program allows user to easily create and attribute <i>new</i> scenarios on a map through standard ArcGIS editing tools or web-based editing tools.		
D-05.1	R	Provide the functionality for the user to update the current network (copy and edit) for any given scenario. Make sure that any new alignments are snapped to the network, maintain connectivity, and contain the attributes necessary to process the model.
G-06: Program allows user to easily attribute scenarios on a map through standard ArcGIS editing tools or web-based editing tools on <i>existing</i> roadways.		
D-06.1	M	Provide the functionality for the user to update the current network (copy and edit) for any given scenario.
G-08: Provide the output in an easy to use format (Excel and GIS) and in a standard, accessible folder structure or easily retrieved from system.		
D-08.1	R	Cost-Benefit outputs are useable in the current Microsoft Excel version.
D-08.2	R	Maintain a primary key to link geospatial output to standard geometries: County, District, and State.
G-09: Benefit-cost numbers are needed on the following levels: County, District, and State.		
D-09.1	D	Return the final benefit-costs from REMI on each of the levels.
G-12: Save the processed scenarios indefinitely, in a way that is easily queried and results are accessible.		
D-12.1	R	Save and maintain all processed scenarios, their parameters, module inputs & outputs.
D-12.2	R	Provide the functionality for the user to view previous model results.
D-12.3	R	Provide the functionality for the user to use and modify the inputs of a previous completed scenario. Allow the user to adjust the parameters and options modules, and then process them as a new scenario.



4.4 Functional Requirements

Functional Requirements define what the system must do to support the business needs. They specify, at a detailed level, computer system requirements within the context of the processes they must support.

#	Priority	Requirement Description
G-01: New functionality must utilize dynamic MDT data sources.		
F-01.1	D	Provide the functionality for the user to continue with the current HEAT network or rebuild and reprocess the network based on the dynamic data sources.
F-01.2	R	Provide the functionality for the user to select from the current TCP projects.
G-02: Economic modeling capability maintained from current version.		
F-02.1	M	The Assignment Routine Module will process for all scenarios. The existing “no-build” network will be used to process the scenarios (or be processed during the same method).
F-02.2	M	The Accessibility Module will process for all scenarios. The existing “no-build” network will be stored and retrieved to process the scenarios (or be processed during the same method).
F-02.3	M	The User Benefit Module will process for all scenarios. The existing “no-build” network will be used to process the scenarios (or be processed during the same method).
F-02.4	R	The user will select whether or not to process the Business Attraction Module.
F-02.5	R	The user will select whether or not to process the Visitor Attraction Module.
F-02.6	M	Cost Estimation Module will be processed for all scenarios.
F-02.7	M	REMI analysis will be processed for all scenarios.
F-02.8	M	The final Benefit/Cost analysis will be performed for all scenarios; benefit/cost analysis numbers will be stored for existing network (“no-build” scenario).
G-03: New functionality utilizes current software versions (REMI, ArcGIS, Excel or similar).		



F-03.1	R	When utilizing Esri software, it will be executed on ArcGIS (Server or Desktop) version 10.
F-03.2	R	REMI processing will take place with the newest version of PI+, currently version 1.4.3.
F-03.3	R	Data outputs will be compatible with Microsoft Excel 2010 (version 14).
F-03.4	R	Data inputs such as the PET will be compatible with Microsoft Excel 2010 (version 14).
G-04: Cost estimation module must utilize MDT's Project Estimation Tool (PET).		
F-04.1	R	User will review and, as necessary, modify PET spreadsheets as HEAT input. Similar to the current program, HEAT will agglomerate similar improvements for combined cost estimation and enable changes by the user.
G-05: Program allows user to easily create and attribute <i>new</i> scenarios on a map through standard ArcGIS editing tools or web-based editing tools.		
F-05.1	R	Provide the functionality for a user to attribute and draw a realignment scenario.
F-05.2	R	Use the user input from a realignment scenario to integrate and attribute the scenario to the HEAT network.
G-06: Program allows user to easily attribute scenarios on a map through standard ArcGIS editing tools or web-based editing tools on <i>existing</i> roadways.		
F-06.1	R	Provide user editing tools to change attributes of the roadway network.
G-07: Reports, graphs and charts of outputs maintained from current version.		
F-07.1	M	Output the final cost-benefit numbers in a way that it can be utilized in Microsoft Excel.
F-07.2	D	Provide the desire line tool analysis with current functionality.
G-08: Provide the output in an easy to use format (Excel and GIS) and in a standard, accessible folder structure or easily retrieved from system.		
F-08.1	R	Output the model results into an Excel compatible format.
F-08.2	R	Output the model result into a current ArcGIS compatible format.



F-08.3	R	Allow the user to retrieve HEAT2 outputs on demand and/or store in an accessible, and easy to navigate directory structure.
G-09: Benefit-cost numbers are needed on the following levels: County, District, and State.		
F-09.1	R	The REMI output must be available at all desired scales. (County may not be available at this time.)
G-10: Provide a model parameter page in a similar fashion to the current cost estimation page. Allows user to input parameters such as the price of gasoline, price of life, oil price index and others.		
F-10.1	R	Provide a model parameter page/window/dialog for the user to specified important values in the model processing.
F-10.2	R	Provide default values for those parameters.
F-10.3	R	Provide a function/configuration for the user to change the model's default values.
G-11: Provide a way for the user to select which modules to run for the scenario.		
F-11.1	R	Provide a page/window/dialog for the user to choose the optional modules to be processed.
G-12: Save the processed scenarios indefinitely, in a way that is easily queried and results are accessible.		
F-12.1	R	Provide the user the functionality to view a list of all previously processed scenarios.
F-12.2	R	Provide the functionality to view previously processed scenarios and retrieve the results of those scenarios.
F-12.3	R	Allow the user to use the parameters of a previously ran scenario, with the ability to change the parameter and process or not process optional modules.
G-13: Once the parameters and modules are specified by the user, the model runs through completion without any further user interaction.		
F-13.1	R	After all inputs (cost estimation, scenario editing, model parameters, modules to-be run) are specified, the scenario is processed to completion.



F-13.2	R	Provide a status page/window/dialog for the user to view which modules have completed, what is currently being processed, and what is to be processed.
G-14: Provide notification to the user when the model has completed.		
F-14.1	R	When the model has completed provide the user with notification through email or another common method of automated communication.
G-15: From the initiation of a scenario, the processing time should be less than one hour.		
F-15.1	D	Preprocessing from the “no-build” scenario should be saved and utilized by further scenarios.
F-15.2	D	When the “no-build” network is updated, process the scenario to the extent practicable and save it to be used in further processing.
G-16: Source code to be open.		
F-16.1	R	Source code to be checked into MDT subversion database.

4.5 Performance and Quality Requirements

Performance and Quality Requirements define how the system must function in terms of hours of operation, response times and throughput.

#	Priority	Requirement Description
P-01	M	The system will be available daily from 5:00 AM to 7:00 PM.
G-15: From the initiation of a scenario, the processing time should be less than one hour.		
P-15.1	D	Once the inputs are specified by the user, a complete HEAT2 scenario will be processed within one hour.

4.6 Security and Access Requirements

Security and Access Requirements are determined by the system owner. They specify the classifications and levels of access protection required for the system.

#	Priority	Requirement Description
---	----------	-------------------------



S-01	R	Only designated Planning staff and ISD maintenance staff will have access to the HEAT2 tools.
S-02	M	The workstation and server performing the HEAT2 function will have all necessary system permissions in order to do the work.

4.7 Communication Requirements

The Communication Requirements define the connectivity and access of the system within and between end-users and other applications.

#	Priority	Requirement Description
CM-01	R	The system will be available to those who are designated from their personal CPUs.
CM-02	R	Connectivity to the Oracle databases (prod & prod2) is required.
CM-03	D	The system will have internet connectivity.

4.8 Backup, Restore and Recovery Requirements

The requirements for backup restore and recovery ensure the continuity of operations of the system. If the system is mission critical, a continuity of operations plan should be developed.

#	Priority	Requirement Description
BR-01	R	The system will follow established MDT backup and recovery standards.
BR-02	R	The system (server or desktop) will be imaged on a regular cycle so it can be recovered quickly.

4.9 Training Requirements

Training Requirements define who needs initial training, what materials are need, how develops the training, to whom and where, who handles ongoing training, and if ISD User Support will be involved.

#	Priority	Requirement Description
---	----------	-------------------------



TR-01	R	ISD will provide the Planning staff with the necessary training to maintain the system configuration.
TR-02	R	Planning will train the necessary staff on system usage.
TR-03	R	Provide user documentation for the system.

4.10 Ongoing Maintenance and Support Requirements

These requirements define the expectations the user has for maintenance and support of the system into the future.

#	Priority	Requirement Description
MS-01	R	The system must be kept up-to-date with the latest datasets.
MS-02	R	Requests for bug fixes will be entered into Help Desk. Bug fix requests will be acknowledged within one business day.
MS-03	R	System support will be provided during regular business hours.
MS-04	D	The system should be functioning through major software upgrade cycles.



Appendix A - Business Data Model

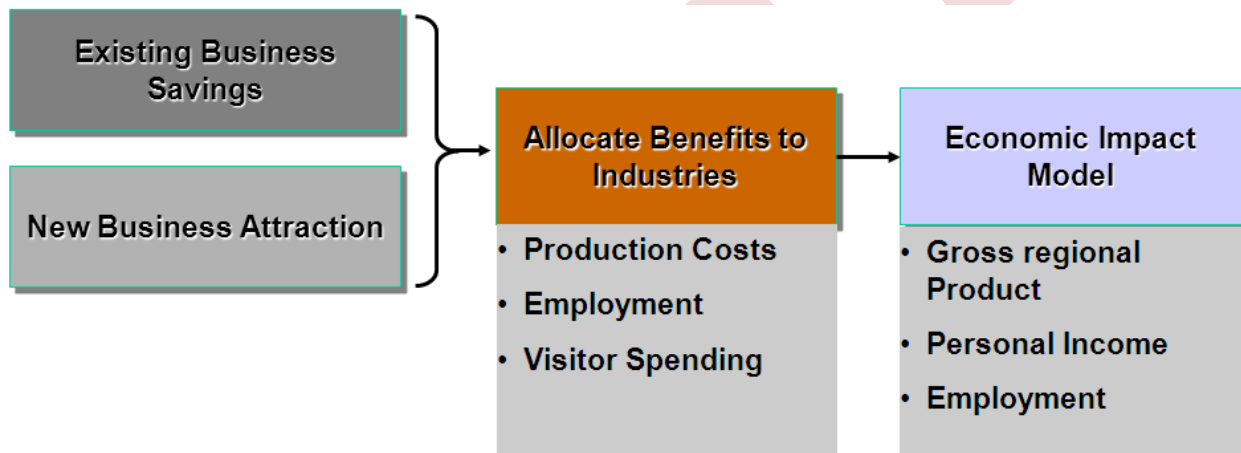
Data entities, relationships and data elements to support the core business processes and requirements are defined below.

This information provides the technical details to enable the system design team to determine how and where the system's data will be stored, the dependencies between the data, how the business rules will be implemented, etc.

A 1.0 Data Models

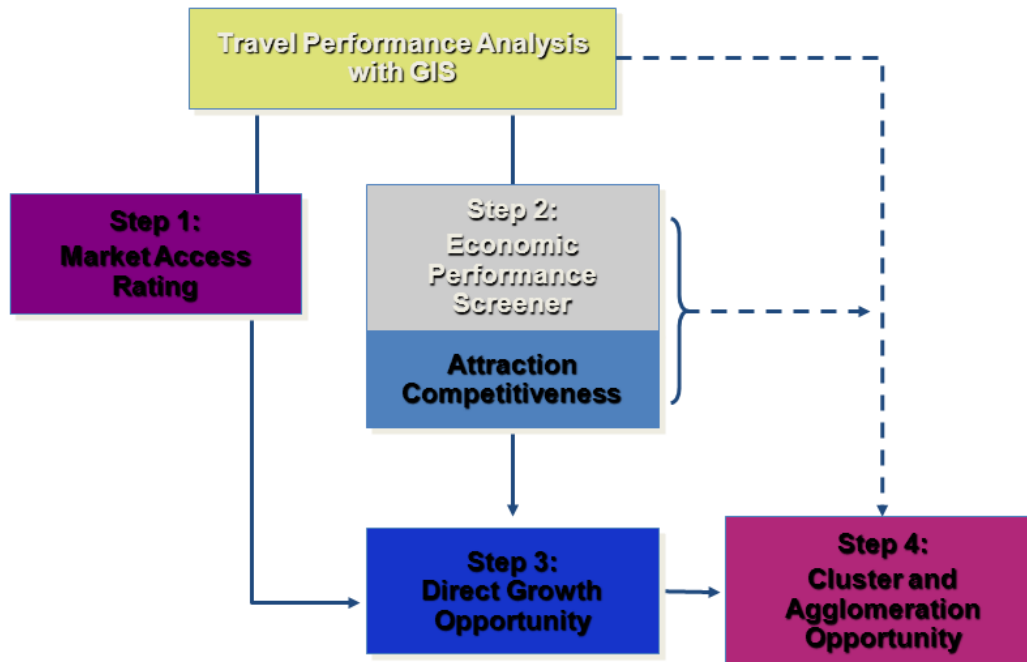
The diagrams in Appendix A illustrate the major data entities and relationships involved in the core business processes of the system.

A 1.1 Allocation of Direct Benefits to Industries



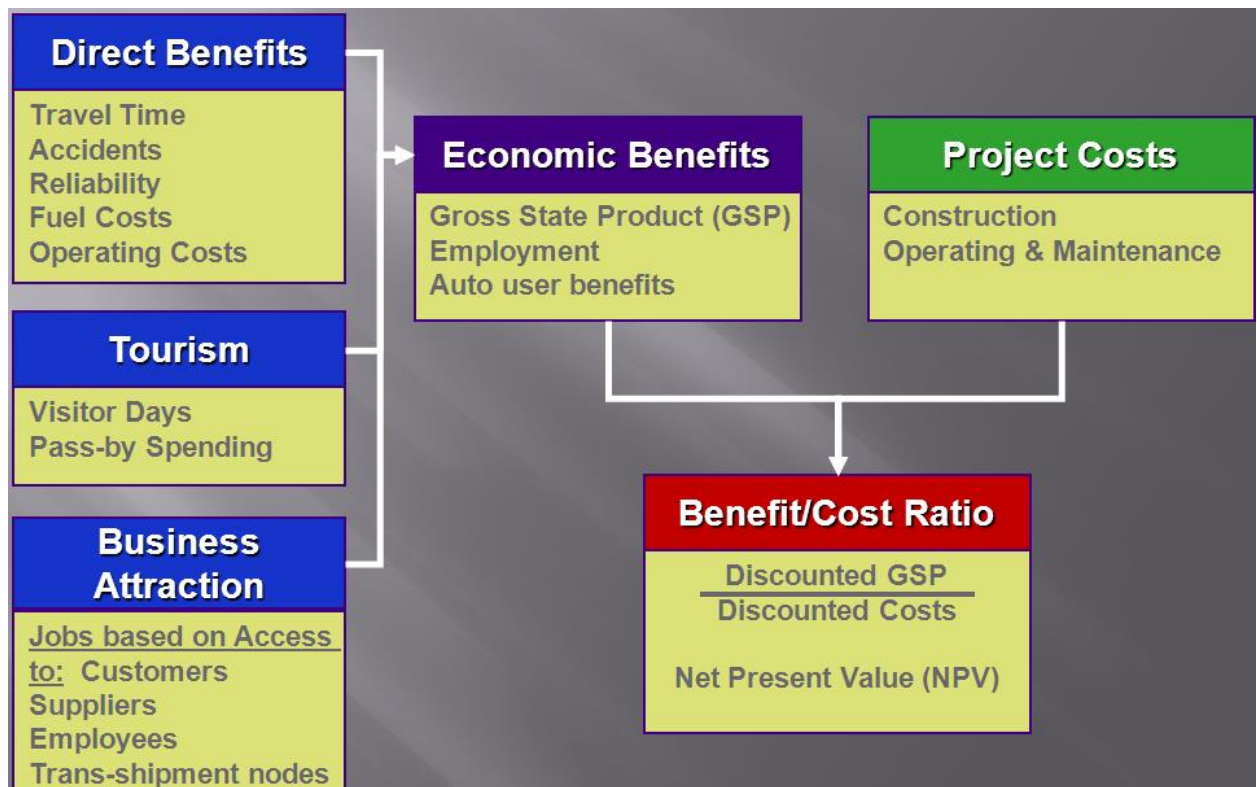


A 1.2 Business Attraction Model Steps:



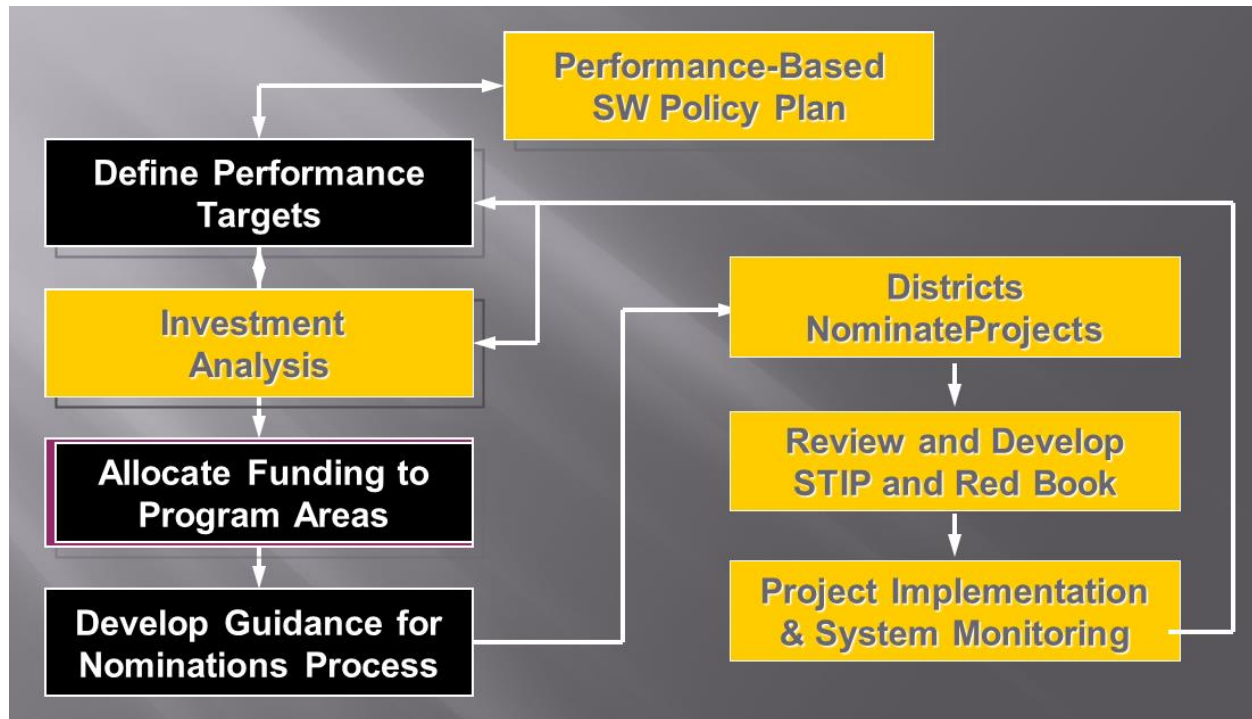


A 1.3 Benefit/Cost Analysis:





A 1.4 Performance Programing Process (P3) Process:



**A 1.5 Cost estimation/PET:****Instructions:**

Please enter all requested information below (make sure Excel macros are enabled). After completing this section, please refer to the "Cost Estimate" tab at the bottom of the spreadsheet to view the estimated cost breakdown. Unit prices can be adjusted to match current bid tabs and MDT's average price items catalog.

1) Project units:

- a. ☐ Metric
b. ☒ English Note: Re-enter quantities in sections 5 & 6 if units are changed.

2) Project type:

- a. ☒ Rural
b. ☐ Urban

3) Cross section type:

- a. ☐ 4-lane roadway on new alignment [80 ft (24.2m) width]
b. ☐ Expand a 2-lane road to 4 lanes [80 ft (24.2m) total width, includes 2" (50mm) overlay on existing 2-lanes]
c. ☐ Major Rehabilitation on existing alignment [enter new & existing roadway widths in sections 6a & 6g]
d. ☒ Overlay Project [enter overlay width & thickness in section 6e & 6f]
e. ☐ 2-lane roadway on new alignment [enter roadway width in section 6a]

4) Other features (check box only if applies):

- a. ☐ Mountainous region

5) Enter project information:

	Quantity	Units
a. Length of roadway	4.3	miles
b. Number of passing lanes		each
c. Number of turn lanes		each
d. Number of signalized intersections		each
e. Number of interchanges		each
f. Number of interchange removals		each
g. Number of new overpasses 100 lin ft or less		each
h. Number of new overpasses over 100 lin ft		
i. Number of overpass removals		each
j. Length of railroad relocation		miles

6) Enter typical section dimensions

	Quantity	Units
a. Roadway surface width (see section 3c or 3e.)	80	feet
b. Asphalt Concrete Thickness	6	inch
c. Crushed Top Thickness		inch
d. Granular Base Thickness	24	inch
e. Overlay width (see section 3d.)		feet
f. Overlay Thickness (see section 3d.)		inch
g. Existing roadway width (see section 3c.)	30	feet

Preliminary Estimated Cost

Construction Cost:	\$205,183
Construction Engineering:	\$20,518
Contingency:	\$20,518
Subtotal:	\$246,220

Enter estimated Right-of-Way cost:	\$24,622
Subtotal:	\$270,842

Enter number of years until project is constructed:	5 Years
Enter inflation rate:	3 %

Total future projected project cost: **\$314,614**



A 2.0 Data Entity Descriptions

The following table describes the system's major data entities.

[Note: If using Designer, a customized repository query may be used to load this table. See documentation at: \\astro\ora_app\mdt\std\sys\doc\reposit_sql.doc]

+	Entity Description
[Enter Entity Name]	[Enter entity description.]

A 3.0 Data Entity Relationships

The relationships between the system's major data entities are described in the following table.

[Note: If using Designer, a customized repository query may be used to load this table. See documentation at: \\astro\ora_app\mdt\std\sys\doc\reposit_sql.doc]

[Enter relationship description.]

A 4.0 Data Element Descriptions

The following table identifies the major data elements to support the core business requirements of the system.

[Note: If using Designer, a customized repository query may be used to load this table. See documentation at: \\astro\ora_app\mdt\std\sys\doc\reposit_sql.doc]

Data Element Name	Attributes	Data Element Description
[Enter Data Element Name]	[Enter Data Type & Length]	[Enter data element description.]



A 5.0 Example Reports

The following screen shots depict current report samples from HEAT, required also for HEAT2:

Selection from a benefit/cost data table:
This output shows data from REMI, exported into an Excel sheet

	A	G	H	I	J	K	L	M
13								
14	COSTS							
15		2010	2011	2012	2013	2014	2015	2016
16	Capital Investment Costs	-	-	-	-	-	-	-
17	Operating and Maintenance Costs	-	-	-	-	-	-	-
18	Thin Lift Overlay	-	-	-	-	-	-	-
19	Total Costs	-	-	-	-	-	-	-
20	Discounted Total Costs	-	-	-	-	-	-	-
21		-	-	-	-	-	-	-
22	PV of Costs	-	-	-	-	-	-	-
23								
24	BENEFITS							
25		2010	2011	2012	2013	2014	2015	2016
26	GSP from REMI	0	0	0	0	1131010	0	1131010
27	Non-Business Auto Benefits	0	0	0	0	0	0	0
28								
29	Total Benefits	0	0	0	0	1,131,010	0	1,131,010
30	Discounted Total Benefits	0	0	0	0	794,633	0	734,683
31								
32	PV of Benefits							
33								
34	NPV							
35	B/C RATIO							
36								
37	REMI GSP (Mil chained 96\$)	0	0	0	0	0.001	0	0.001
38	2003 dollars	0	0	0	0	1131010	0	1131010

HEAT2 – Requirements Document

Selected outputs from REMI analysis are exported to an Excel sheet for display and analysis.

[illegible]

HEAT2 – Requirements Document

[illegible]

Output showing selected parameters of the Benefit-Cost analysis

HEAT - Benefit/Cost Analysis		0					
(assumes State-level B/C)							
Inputs							
Year construction begins	2006						
Year construction ends	2008						
Year benefits begin							
Discount rate	4.0%						
B/C time period of analysis (# of years)	30	Default Value					
Discount stream	2013	2014	2015	2016	2017	2018	2019
	1.000	0.9615	0.9246	0.8890	0.8548	0.8219	0.7903
COSTS							
	2005	2006	2007	2008	2009	2010	2011
Capital Investment Costs	-	-	-	-	-	-	-
Operating and Maintenance Costs	-	-	-	-	-	-	-
Thin Lift Overlay	-	-	-	-	-	-	-
Total Costs	-	-	-	-	-	-	-
Discounted Total Costs	-	-	-	-	-	-	-
	-	-	-	-	-	-	-
PV of Costs	-	-	-	-	-	-	-
BENEFITS							
	2005	2006	2007	2008	2009	2010	2011
GSP from REMI	0				0	1131010	1131010
Non-Business Auto Benefits	0				0	0	0
Total Benefits	95,004,840	-	-	-	-	1,131,010	1,131,010
Discounted Total Benefits		-	-	-	-	929,608	893,854
PV of Benefits	43,008,704						
NPV	\$ 43,008,704						
B/C RATIO	No PV of Costs						



HEAT2 – Requirements Document

REMI GSP (Mil chained 96\$)		0	0	0.001	0	0.001	0.001
2003 dollars	1.13101	0	0	1131010	0	1131010	1131010

I/O Impacts by broad industry group. This is a brief example of output by MDT region and industry group for use in estimation of economic impacts

REMI 1					
REMI Industry	2008	2009	2010	2011	2012
Durable Goods	-0.017681737121	-0.018289988878	-0.018919164496	-0.019569983754	-0.020243191195
Nondurable Goods	-0.001986847645	-0.002055195204	-0.002125893919	-0.002199024670	-0.002274671119
Mining (10, 12-14)	-0.001858883969	-0.001922829578	-0.001988974915	-0.002057395652	-0.002128170063
Construction (15-17)	-0.027864127320	-0.028822653299	-0.029814152573	-0.030839759421	-0.031900647145
Transportation and Public Utilities	-0.101598588301	-0.105093579738	-0.108708798881	-0.112448381563	-0.116316605889
FIRE	-0.000829125203	-0.000857647110	-0.000887150171	-0.000917668137	-0.000949235920
Retail	-0.034111358404	-0.035284789133	-0.036498585880	-0.037754137234	-0.039052879555
Wholesale (50-51)	-0.014816280563	-0.015325960614	-0.015853173659	-0.016398522833	-0.016962632019
Services	-0.031262896080	-0.032338339705	-0.033450778591	-0.034601485374	-0.035791776471
Agri/F/F (07-09)	-0.002945493655	-0.003046818637	-0.003151629198	-0.003260045242	-0.003372190799
REMI 2					
REMI Industry	2008	2009	2010	2011	2012
Durable Goods	-0.066136390277	-0.068411482103	-0.070764837087	-0.073199147483	-0.075717198156
Nondurable Goods	-0.017702654832	-0.018311626158	-0.018941546098	-0.019593135284	-0.020267139138
Mining (10, 12-14)	-0.044728216221	-0.046266866859	-0.047858447079	-0.049504777659	-0.051207742010
Construction (15-17)	-0.206224643068	-0.213318770790	-0.220656936505	-0.228247535121	-0.236099250329
Transportation and Public Utilities	-0.605439303232	-0.626266415263	-0.647809979948	-0.670094643258	-0.693145898986
FIRE	-0.006482549794	-0.006705549507	-0.006936220410	-0.007174826392	-0.007421640420
Retail	-0.264112820772	-0.273198301807	-0.282596323389	-0.292317636914	-0.302373363623
Wholesale (50-51)	-0.107406253245	-0.111101028357	-0.114922903732	-0.118876251621	-0.122965594677
Services	-0.226672739440	-0.234470281677	-0.242536059366	-0.250879299808	-0.259509547722
Agri/F/F (07-09)	-0.021463350858	-0.022201690128	-0.022965428268	-0.023755439000	-0.024572626102
REMI 3					
REMI Industry	2008	2009	2010	2011	2012
Durable Goods	-0.018368961788	-0.019000854073	-0.019654483454	-0.020330597684	-0.021029970245
Nondurable Goods	-0.017773037343	-0.018384429828	-0.019016854214	-0.019671033999	-0.020347717568
Mining (10, 12-14)	-0.030529796048	-0.031580021032	-0.032666373755	-0.033790097013	-0.034952476350
Construction (15-17)	-0.187752749858	-0.194211444453	-0.200892318142	-0.207803013886	-0.214951437564
Transportation and Public Utilities	-0.573834668741	-0.593574581346	-0.613993546944	-0.635114924959	-0.656962878378
FIRE	-0.008593479082	-0.008889094762	-0.009194879622	-0.009511183481	-0.009838368193
Retail	-0.259336160853	-0.268257324786	-0.277485376759	-0.287030873719	-0.296904735775
Wholesale (50-51)	-0.130850498692	-0.135351755847	-0.140007856248	-0.144824126503	-0.149806076455
Services	-0.243354404504	-0.251725796019	-0.260385163403	-0.269342413024	-0.278607792032
Agri/F/F (07-09)	-0.017656718743	-0.018264109868	-0.018892395247	-0.019542293644	-0.020214548545



Integration of Preliminary Estimation Tool (PET) tracks costs: HEAT integrates this cost estimation facility into its analysis

Item Number	Quantities	Description	Unit	Average Bid Prices		District Unit Prices	
				Unit Prices Dollars	Amount Dollars	Unit Prices Dollars	Amount Dollars
1	105.000000	BLUETOPE STAKING	CYRM	\$2.81.00	\$293,943.00		\$293,943.00
2	20.000000	EXCAVATION UNCLASSIFIED	MS	\$2.79	\$55,800.00		\$55,800.00
3	20.000000	EXCAVATION UNCLASSIFIED	MS	\$2.30	\$46,000.00		\$46,000.00
4	20.000000	SPECIAL BORROW	MS	\$10.13	\$202,600.00		\$202,600.00
5	50.000000	DOZER	HOUR	\$125.00	\$6,250.00		\$6,250.00
			MS	\$2.14	\$3,507,507.00		\$3,507,507.00
			MS	\$26.33	\$0.00		\$0.00
			MS	\$24.20	\$74,430.00		\$74,430.00
			MS	\$17.49	\$3,498.00		\$3,498.00
			MS	\$10.00	\$20,780.00		\$20,780.00
			MS	\$13.05	\$1,088,667.00		\$1,088,667.00
			MS	\$114.75	\$126,225.00		\$126,225.00
			MS	\$257.11	\$1,180,743.00		\$1,180,743.00
			MS	\$259.72	\$91,758.00		\$91,758.00
			L	\$0.21	\$11,506.00		\$11,506.00
			MS	\$262.54	\$105,909.00		\$105,909.00
			MS	\$39.00	\$17,570.00		\$17,570.00
			MS	\$71.32	\$3,213.00		\$3,213.00
			LOMT	\$2,250.00	\$10,107.00		\$10,107.00
			EACH	\$2,100.00	\$3,461.00		\$3,461.00
			MS	\$4.67	\$54,157.00		\$54,157.00
			MS	\$46.00	\$0.00		\$0.00
			MS	\$63.58	\$0.00		\$0.00
			MS	\$43.40	\$0.00		\$0.00
			HA	\$40.15	\$9,239.00		\$9,239.00
			HA	\$2,341.43	\$14,768.00		\$14,768.00
			HA	\$371.00	\$3,343.00		\$3,343.00
			HA	\$122.07	\$2,750.00		\$2,750.00
			HA	\$383.33	\$2,481.00		\$2,481.00
			HA	\$54.54	\$2,679.00		\$2,679.00
			HA	\$5,550.00	\$75,005.00		\$75,005.00
			LOMT	\$1.00	\$250,291.00		\$250,291.00
			HOUR	\$26.00	\$170,254.00		\$170,254.00
			HOUR	\$38.73	\$14,906.00		\$14,906.00
			RM	\$2,680.00	\$24,148.00		\$24,148.00
			RM	\$7,500.00	\$0.00		\$0.00
			RM	\$16,500.00	\$14,417.00		\$14,417.00
			RM	\$57,550.00	\$0.00		\$0.00
			RM	\$75,000.00	\$675,780.00		\$675,780.00
			LS	\$7,500,000.00	\$0.00		\$0.00
			LS	\$12,000,000.00	\$0.00		\$0.00
			LS	\$50,000.00	\$0.00		\$0.00
			LS	\$1,000,000.00	\$0.00		\$0.00
			LS	\$50,000.00	\$0.00		\$0.00
			RM	\$375,000.00	\$0.00		\$0.00
			LS	\$200,000.00	\$0.00		\$0.00
			RM	\$120,670.00	\$0.00		\$0.00
					\$8,762,858.00		\$8,762,858.00
					\$876,285.80		\$876,285.80
					\$9,639,143.80		\$9,639,143.80
					\$963,914.38		\$963,914.38
					\$11,566,972.56		\$11,566,972.56

PET (Preliminary Estimating Tool)

1) **Project no.:** (Enter new quantities in sections 5 & 6 if units are changed.)
a. ☐ Metric
b. ☒ English

2) **Project type:**
a. ☒ Rural
b. ☐ Urban

3) **Overlaid section type:**
a. ☐ 4-lane roadway on new alignment (30 ft (9.1m) width); (enter thickness in sections 5b - 5d)
b. ☐ Expand a 2-lane road to 4 lanes (30 ft (9.1m) total width); includes 2' (60mm) overlay on existing 2-lane; (enter thickness in sections 5b - 5d)
c. ☒ Major Rehabilitation on existing alignment (enter new & existing roadway widths in sections 5a & 5g, and thickness in sections 5b - 5d)
d. ☐ Overlay Project (enter overlay width & thickness in section 5a & 5f)
e. ☐ 2-lane roadway on new alignment (enter roadway width in section 5a, and thickness in sections 5b - 5d)

4) **Other features (check box only if applicable):**
a. ☐ Haulage system

5) **Enter project information:**
a. Length of roadway: _____ miller
b. Number of paving lanes: _____ each
c. Number of turn lanes: _____ each
d. Number of signalized intersections: _____ each
e. Concrete Roundabout - One Lane: _____ each
f. Concrete Roundabout - Two Lanes: _____ each
g. Number of new Rural Interchange: _____ each
h. Number of new Urban/Interstate Interchange: _____ each
i. Number of Rural Interchange removal: _____ each
j. Number of Urban/Interstate Interchange removal: _____ each
k. Number of new bridge 100 linear foot or less: _____ each
l. Number of new bridge larger than 100 linear foot: _____ each
m. Number of small truss span bridge removal: _____ each
n. Number of large multiple span bridge removal: _____ each
o. Lane miller of milling: _____ miller
p. Length of railroad relocation: _____ miller

6) **Enter typical section dimensions:**
a. Roadway surface width: _____ foot
b. Surfacing Thickness: _____ inch
c. Crushed Top Thickness: _____ inch
d. Granular Base Thickness: _____ inch
e. Overlay width: _____ foot
f. Overlay Thickness: _____ inch
g. Existing roadway width: _____ foot

Preliminary Estimated Cost
Construction Cost: \$0
Construction Engineering: \$0
Contingency: \$0
Subtotal CM+CE: \$0
Enter estimated Right-of-Way cost: _____
Total CM+CE+RW: \$0

Note: To calculate inflation, see Inflation Tool link. Adjust CE and Contingency percentages on the Estimate link.



Inputs to REMI business attraction module

	A	B	C	O	P	Q	R	S	T	U	V	W
1	REMI 1	2014	year of project completion									
2	REMI INDUSTRY	2001	2002	2014	2015	2016	2017	2018	2019	2020	2021	2022
3	Forestry, Fishing, Other	0	0	14.17778	28.35555	42.53333	56.7111	70.88888	85.06665	99.24443	113.4222	127.6
4	Mining	0	0	2.85359	5.70718	8.56077	11.41436	14.26795	17.12154	19.97513	22.82872	25.68231
5	Utilities	0	0	5.60724	11.21448	16.82172	22.42896	28.0362	33.64344	39.25068	44.85792	50.46516
6	Construction	0	0	0	0	0	0	0	0	0	0	0
7	Manufacturing	0	0	88.15734	176.3147	264.472	352.6293	440.7867	528.944	617.1013	705.2587	793.416
8	Wholesale Trade	0	0	0	0	0	0	0	0	0	0	0
9	Retail Trade	0	0	0	0	0	0	0	0	0	0	0
10	Transportation, Warehousing	0	0	4.226345	8.45269	12.67904	16.90538	21.13173	25.35807	29.58442	33.81076	38.03711
11	Information	0	0	3.884965	7.76993	11.6549	15.53986	19.42483	23.30979	27.19476	31.07972	34.96469
12	Finance, Insurance	0	0	27.45035	54.9007	82.35105	109.8014	137.2518	164.7021	192.1525	219.6028	247.0532
13	Real Estate, Rental, Leasing	0	0	0	0	0	0	0	0	0	0	0
14	Professional, Technical Services	0	0	24.75868	49.51735	74.27603	99.0347	123.7934	148.5521	173.3107	198.0694	222.8281
15	Management of Companies, Enterprises	0	0	0	0	0	0	0	0	0	0	0
16	Administrative & Waste Svcs	0	0	0	0	0	0	0	0	0	0	0
17	Educational Services	0	0	16.49991	32.99982	49.49973	65.99964	82.49955	98.99946	115.4994	131.9993	148.4992
18	Health Care, Social Assistance	0	0	21.7868	43.5736	65.3604	87.1472	108.934	130.7208	152.5076	174.2944	196.0812
19	Arts, Entertainment, Recreation	0	0	0	0	0	0	0	0	0	0	0
20	Accommodation, Food Svcs	0	0	0	0	0	0	0	0	0	0	0
21	Other Services	0	0	0	0	0	0	0	0	0	0	0
22	Farm	0	0	6.16502	12.33004	18.49506	24.66008	30.8251	36.99012	43.15514	49.32016	55.48518
23												
24	REMI 2											
25	REMI INDUSTRY	2001	2002	2014	2015	2016	2017	2018	2019	2020	2021	2022
26	Forestry, Fishing, Other	0	0	11.53638	23.07275	34.60913	46.1455	57.68188	69.21825	80.75463	92.291	103.8274
27	Mining	0	0	0.766825	1.53365	2.300475	3.0673	3.834125	4.60095	5.367775	6.1346	6.901425
28	Utilities	0	0	1.761485	3.52297	5.284455	7.04594	8.807425	10.56891	12.3304	14.09188	15.85337
29	Construction	0	0	0	0	0	0	0	0	0	0	0
30	Manufacturing	0	0	49.91032	99.82064	149.731	199.6413	249.5516	299.4619	349.3722	399.2826	449.1929
31	Wholesale Trade	0	0	0	0	0	0	0	0	0	0	0
32	Retail Trade	0	0	0	0	0	0	0	0	0	0	0
33	Transportation, Warehousing	0	0	3.787705	7.57541	11.36312	15.15082	18.93853	22.72623	26.51394	30.30164	34.08935
34	Information	0	0	3.1277	6.2554	9.3831	12.5108	15.6385	18.7662	21.8939	25.0216	28.1493
35	Finance, Insurance	0	0	19.78428	39.56855	59.35283	79.1371	98.92138	118.7057	138.4899	158.2742	178.0585
36	Real Estate, Rental, Leasing	0	0	0	0	0	0	0	0	0	0	0
37	Professional, Technical Services	0	0	11.57195	23.1439	34.71585	46.2878	57.85975	69.4317	81.00365	92.5756	104.1476
38	Management of Companies, Enterprises	0	0	0	0	0	0	0	0	0	0	0
39	Administrative & Waste Svcs	0	0	0	0	0	0	0	0	0	0	0
40	Educational Services	0	0	9.007335	18.01467	27.02201	36.02934	45.03668	54.04401	63.05135	72.05868	81.06602
41	Health Care, Social Assistance	0	0	10.79085	21.58169	32.37254	43.16338	53.95423	64.74507	75.53592	86.32676	97.11761
42	Arts, Entertainment, Recreation	0	0	0	0	0	0	0	0	0	0	0

Durable
Manufacturing

Non-Durable
Manufacturing

Mining

Construction

Transportation &
Public Utilities

Finance &
Insurance &
Real Estate

Retail Trade

Wholesale Trade

Services

Agriculture &
Forestry
Fisheries

Government

Farm

Business Attraction Module:



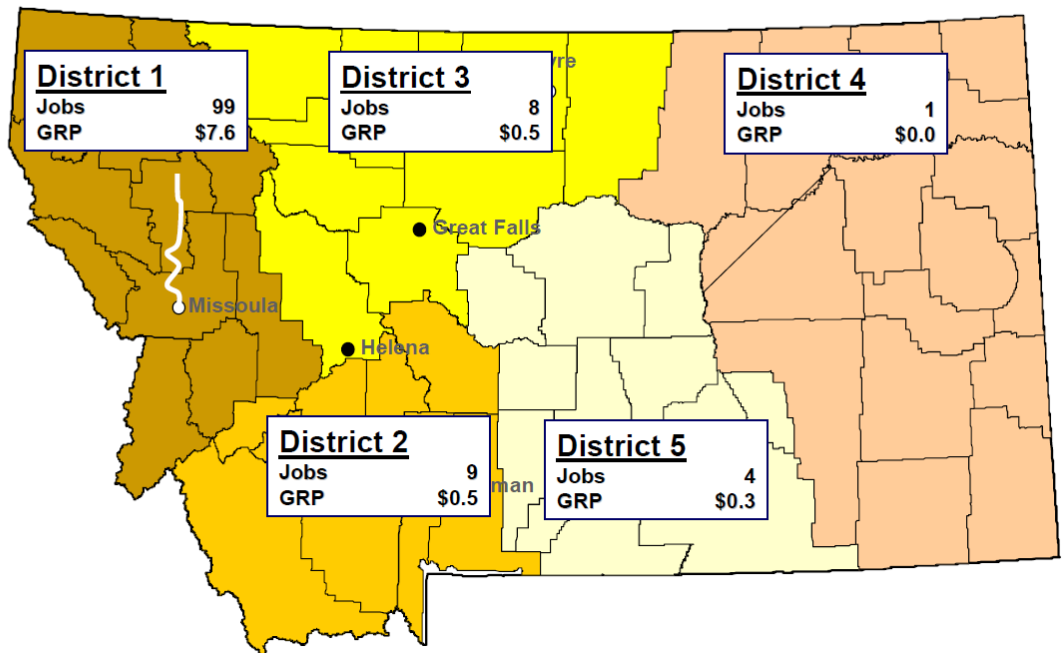
HEAT inputs, a slate of projects for analysis

C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
PROJECT NO	LOCATION	SCOPE OF WORK	LENGTH	COST	ACCESS AREA	FUNCTION	LAN PLAN	EXISTING	P	TERRAIN TYPE	OF 2	MI	LENGTH	BEGM	ENDM	ROUTE	NOC	
STPP 1-1(10)15	PARADISE EAST (EAST SECTION)	G, GS, PMS, STRS	5	6500000				3	2	2		2	5.24	15.00	91.24	00001		
W1-1-1(10)16	(SWAMP CREEK)	RECONSTRUCTION	3									2	2.30	0.00	2.30	00001		
W1-1-1(10)16	CONNER-H & S	RECONSTRUCT & STRUCTURE	9	10935000				2	2	2		3	9.01	16.00	25.01	00007		
W1-1-1(10)140	2 KM WEST OF HUNGRIE HORSE-WEST	RECONSTRUCT & STRUCTURE	2	4066000				2	2	2		2	1.75	140.00	141.75	00001		
STPP 54-1(10)10	MISSION INTERCHANGE - NORTH	RECONSTRUCTION	7	8000000								2	6.90	0.00	6.90	00059		
STPP 55-1(10)10	WHITEHALL-WATERLOO	VIDEN, PMS OVERLAY	12	5000000				3	2	2		2	12.10	0.00	12.10	00055		
STPS 417-1(10)13	BIG MOUNTAIN ROAD	RECONSTRUCTION	5	6325000				4	2	2		3	4.60	3.00	7.60	00017	1	
W1-1-1(10)13	WHITEFISH-WEST	RECONSTRUCT & STRUCTURE	5	11000000				2	2	2		3	5.16	120.00	125.16	00005		
STPP 14-1(10)122	BOULDER - SOUTH	RECONSTRUCT & STRUCTURE	15	17000000								2	14.90	22.00	36.90	00049		
STPS 210-1(10)13	2 PMS OF HARDIN - S	G, GS, PMS	7	4572000				4	2	2		2	7.00	0.00	15.00	00010		
STPS 224-1(10)144	CLAGGETT HILL	RECONSTRUCTION	4	2210000				4	2	2		2	3.90	44.00	47.90	00024		
STPP 52-1(10)126	BIGFORK - H & S	RECONSTRUCTION	7	10330000				3	2	2		3	6.15	26.00	32.15	00052		
STPP 34-1(10)177	HOT SPRINGS - SOUTH	PMS OVERLAY & VIDEN, S & O	9	3514000				3	2	2		2	8.00	7.00	15.00	00024		
STPP 1-1(10)156	THOMPSON RIVER - EAST	G, GS, PMS, STRS	3	7635000				3	2	2		3	3.30	56.00	59.30	00006		
W1-1-1(10)134	HAIRE - EAST	RECONSTRUCTION	10	11034000								4	10.20	384.00	394.20	00001		
W1-1-1(10)139	30 KM NE OF GLENDALE	G, GS, PMS, STRS	10	39000000								3	10.30	19.00	29.30	00020		
W1-1-1(10)137	11 KM N OF HALTA - NORTH	G, GS, PMS OVERLAY	11	12300000				2	2	2		2	10.10	7.00	17.10	00049		
STPP 14-1(10)1207	ROSEBUD COLLINE - EAST	RECONSTRUCT & STRUCTURE	10	11645000								2	10.20	247.00	257.20	00004		
STPP 41-1(10)131	HARDIN - NORTH	RECONSTRUCT & STRUCTURE	10	5440000								3	10.40	1.00	11.40	00040		
W1-1(10)1242	ROCKVALE - LAUREL	RECONSTRUCTION	10	15000000				2	2	2		3	10.20	42.00	52.20	00004		
STPP 45-1(10)128	WHEATLAND COUNTYLINE - N	RECONSTRUCT & STRUCTURE	10	6066000				3	2	2		2	9.50	28.00	37.50	00045		
STPP 41-1(10)142	19 KM NORTH OF HARDIN - NORTH	VIDEN, OVERLAY & FOR S & O	7	2673000				3	2	2		2	6.60	12.00	18.60	00040		
W1-BR 24-2(10)176	LINCOLN - EAST	VIDEN, OVERLAY, REPLACE BRIDGE	7	6705000				2	2	2		3	7.40	76.00	83.40	00024		
W1-1(10)150(10)139	BIG MUDDY CR - EAST	RECONSTRUCTION	5	6431300								2	4.97	629.00	633.97	00001		
W1-17-1(10)163	ASHLAND - EAST	RECONSTRUCT & STRUCTURE	15	14500000				2	2	2		3	14.71	63.00	77.71	00017		
W1-17-1(10)1202(10)139	12 KM EAST OF JORDAN - EAST	RECONSTRUCT & STRUCTURE	10	9450000				2	2	2		2	9.60	220.00	229.60	00057		
STPS 225-1(10)112	JCT HT 15 - EAST (EAST SECTION)	RECONSTRUCT & STRUCTURE	3	4760000				4	2	2		2	2.55	2.00	4.55	00025	1	
STPS 325-1(10)130	JCT US 2 - NORTH	RECONSTRUCTION	12	6007000				4	2	2		2	12.40	0.00	12.40	00025		
STPS 410-1(10)15	JCT S 214 - WEST	RECONSTRUCT & STRUCTURE	4	6858000				4	2	2		2	4.22	5.00	9.22	00020		
W1-BR 1-2(10)150	KALISPELL - WEST	RECONSTRUCT & STRUCTURE	10	22250000				2	5	5		3	9.60	199.00	208.60	00001		
STPS 561-1(10)17	11 KM NORTH OF LIBBY - NORTH	RECONSTRUCTION	10	7490000				4	2	2		2	10.47	7.00	17.47	00017	1	
STPP 14-1(10)143	CHECKERBOARD - MARTINDALE	RECONSTRUCT & STRUCTURE	15	1412000								2	14.67	63.00	77.67	00014		
STPS 357-1(10)19	ALDER - SOUTH	RECONSTRUCTION	5	4475000				4	2	2		2	4.92	0.00	4.92	00057		
STPS 5-1(10)1225-1(10)139	3 KM OF GREAT FALLS - NORTH	RECONSTRUCTION	11	7940000				4	2	2		3	11.35	0.00	11.35	00025		
STPS 234-1(10)130	JCT HT 17 - EAST	RECONSTRUCT & STRUCTURE	6	5220000				4	2	2		2	7.90	0.00	7.90	00024	1	
STPP 14-1(10)179	WHEATLAND COUNTYLINE - EAST	RECONSTRUCT & STRUCTURE	10	9290000				3	2	2		3	10.12	70.00	80.12	00004		
STPS 221-1(10)130	LEWISTOWN - SOUTHEAST	RECONSTRUCTION	9	7150000				4	2	2		2	8.64	0.00	8.64	00020		
STPS 327-1(10)11	BAINVILLE - SOUTH	RECONSTRUCT & STRUCTURE	14	6100000				4	2	2		2	14.40	1.00	15.40	00027		
STPS 564-1(10)15	JCT HT 42 - NORTH	RECONSTRUCTION	7	6825000				4	2	2		2	7.00	15.00	22.00	00019		
W1-1(10)133	SOUTH OF LIBBY - SOUTH	VIDEN, OVERLAY & FOR S & O	7	3130000				2	2	2		3	6.70	38.00	44.70	00001		
W1-1(10)131	NORTH OF DESHET INTCH - NORTH	VIDEN, GS, PMS	3	3404000				2	4	4		2	3.11	1.00	4.11	00005		
W1-1(10)141	EUREKA - NORTH	VIDEN, PMS OVERLAY	7	3000000								3	6.50	101.00	107.50	00005		
STPP 1-1(10)140(10)130	TROUT CREEK - SOUTHEAST	VIDEN, PMS OVERLAY	17	8295000				3	2	2		2	16.70	30.00	46.70	00006		
W1-1(10)154	PLAINS - NORTHWEST	RECONSTRUCTION	7	4820000				3	2	2		2	7.00	69.00	76.00	00006		
W1-1(10)130	GALATA - E&W	VIDEN, OVERLAY & FOR S & O	8	4550000				2	2	2		3	8.27	300.00	308.27	00001		
W1-1(10)130	SE OF MILES CITY - SE	VIDEN, PMS OVERLAY	8	6400000				2	2	2		2	8.30	20.00	28.30	00023		
STPP 17-1(10)130	FORT PECK - NORTHEAST	VIDEN, PMS OVERLAY	13	4750000								2	13.00	0.00	13.00	00017		
STPS 311-2(10)13	HYSHAM - WEST	RECONSTRUCTION	7	5240000				4	2	2		2	6.54	3.00	9.54	00011		



GIS: Selected impacts are exported to the GIS layer that was the source of the analysis. This example shows jobs and GDP impacts

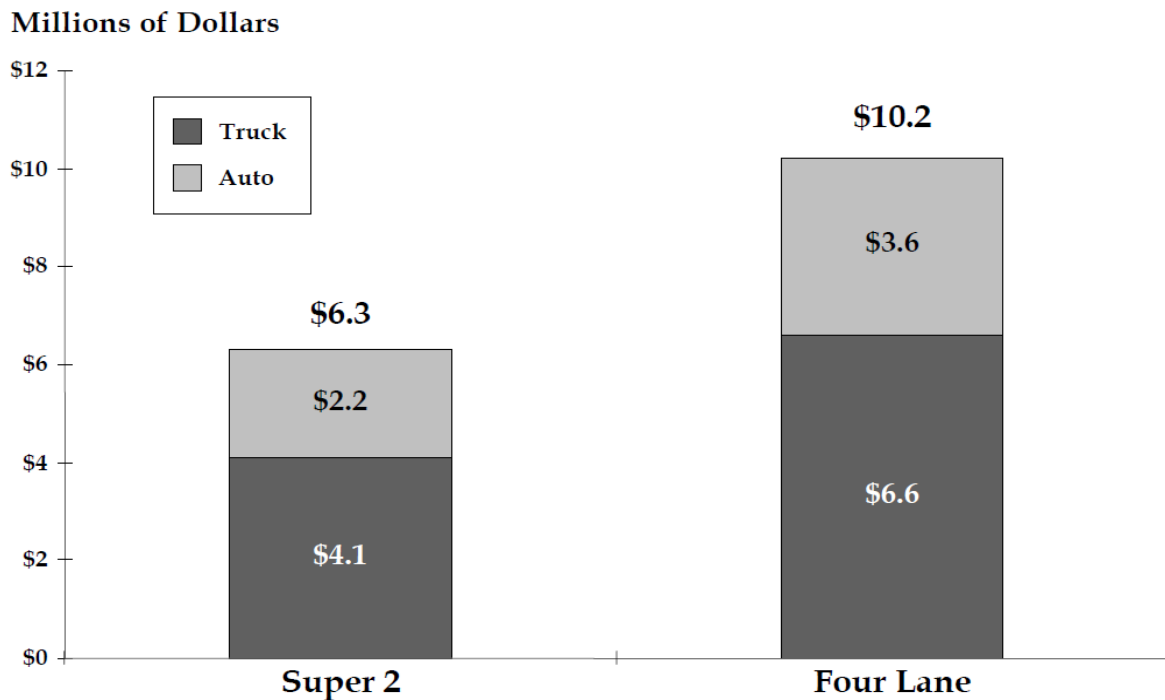
Figure 4.2 U.S. 93 Scenario – Improved Conditions
(Benefits in Millions of Dollars by 2025)





Benefits and costs are graphed within Excel as part of the HEAT output (this graph shows benefits to autos and trucks)

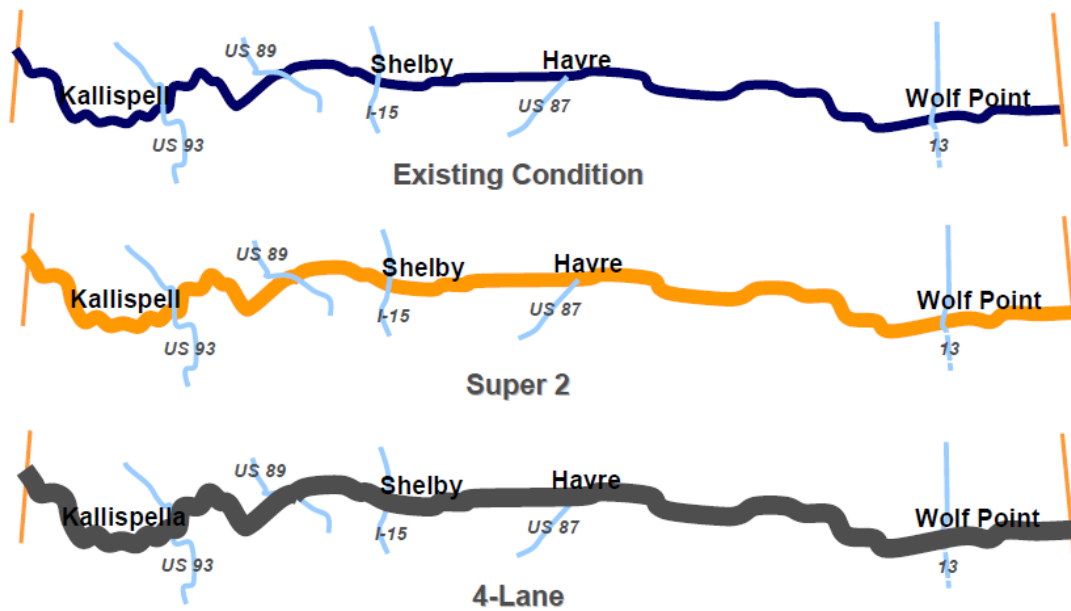
Figure 4.4 User Benefits for U.S. 2 Super 2 and Four-Lane Scenarios
(Millions of 2000 Dollars)





GIS output enables comparison of corridor alternatives
(This is not an output of the program, but an example of mapped scenario analysis that it enables)

Figure 4.3 U.S. 2 Existing Conditions and Improvement Scenarios





Stakeholder's Acceptance/Approval

[The following agree with this document and approve proceeding with the next phase of the project.]

Doug McBroom, Project Authorizer

Date

Hal Fossum, Project Requestor

Date

Miles Wacker, Project CSA Lead

Date

John Kimball, Project Manager

Date